Radioactivity in the Risø District July-December 2013

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Abstract (max. 2000 char.): The environmental surveillance of the Risø environment was continued in July - December 2013. The mean concentrations in air were: 0.20±0.08 μBq m^{-3} of ^{137}Cs, 2.23±0.64 mBq m^{-3} of ^{7}Be and 0.16±0.08 mBq m^{-3} of ^{210}Pb (±1 S.D.; N = 26). The depositions by precipitation at Risø in the second half of 2012 were: 0.048 Bq m^{-2} of ^{137}Cs, 436 Bq m^{-2} of ^{7}Be, 31.3 Bq m^{-2} of ^{210}Pb and < 0.7 kBq m^{-2} of ^{3}H. The average background dose rate (TLD) at Risø (Zone I) was 44 nSv h^{-1} compared with 43 ± 9 nSv h^{-1} (±1 S.D.; N = 4) in the four zones around Risø.

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Table 1. Radionuclides in ground level air collected at Risø (cf. Figs. 1, 1.1 and 1.2), July - December 2013. (Unit: μBq m^{-3})

Date		^{7}Be	^{137}Cs	^{210}Pb
01-Jul-13 –	08-Jul-13	1852	0.144	100
08-Jul-13 –	15-Jul-13	No data	No data	No data
15-Jul-13 –	22-Jul-13	2663	0.380	167
22-Jul-13 –	29-Jul-13	3860	0.273	332
29-Jul-13 –	05-Aug-13	2418	0.098	142
05-Aug-13 –	12-Aug-13	2713	0.099	137
12-Aug-13 –	20-Aug-13	2468	0.074	124
20-Aug-13 –	26-Aug-13	3073	0.263	194
26-Aug-13 –	02-Aug-13	2402	0.211	173
02-Sep-13 –	09-Sep-13	1546	0.117	119
09-Sep-13 –	16-Sep-13	2056	0.146	168
16-Sep-13 –	23-Sep-13	1617	0.124	96
23-Sep-13 –	30-Sep-13	1357	0.202	150
30-Sep-13 –	07-Oct-13	2203	0.278	236
07-Oct-13 –	14-Oct-13	1866	0.197	239
14-Oct-13 –	21-Oct-13	2357	0.238	361
21-Oct-13 –	28-Oct-13	1831	0.084	56
28-Oct-13 –	04-Nov-13	2009	0.143	161
04-Nov-13 –	11-Nov-13	1987	0.153	17
11-Nov-13 –	18-Nov-13	2281	0.293	114
18-Nov-13 –	25-Nov-13	1564	0.280	169
25-Nov-13 –	02-Dec-13	1404	0.221	51
02-Dec-13 –	09-Dec-13	1719	0.220	77
09-Dec-13 –	16-Dec-13	2580	0.310	302
16-Dec-13 –	23-Dec-13	3797	0.276	249
23-Dec-13 –	30-Dec-13	2149	0.266	138
Mean		2231	0.204	163
SD		635	0.080	84

Table 2.1. Radionuclides in precipitation in the 10 m^2 rain collector at Risø (cf. Fig. 1), July - December 2013. (Unit: Bq m^{-3})

Month	^{7}Be	^{137}Cs	^{210}Pb
July	5572	0.671	447
August	2422	0.359	202
September	1666	0.147	142
October	1281	0.140	76
November	1375	0.090	121
December	1906	0.103	106

Table 2.2. Radionuclides in precipitation in the 10 m^2 rain collector at Risø (cf. Fig. 1), July - December 2013. (Unit: Bq m^{-2})

Month	Precipitation (m)	^{7}Be	^{137}Cs	^{210}Pb
July	0.011	60	0.0072	5.1
August	0.018	44	0.0065	3.6
September	0.048	80	0.0071	6.8
October	0.081	104	0.0139	6.2
November	0.031	43	0.0073	3.8
December	0.055	105	0.0057	5.8
Sum	0.244	436	0.0477	31.3

Table 2.3. Tritium in precipitation collected at Risø (cf. Figs. 1, 2.3.1 and 2.3.2). July - December 2013. (Unit: kBq m^{-3})

Month	10 m^2 rain collector*
July	3.9
August	2.2
September	< 2.5
October	< 2.5
November	< 2.5
December	< 2.5

Double determinations*.

Table 2.4. Tritium in precipitation collected at Risø (cf. Fig. 1). July - December 2013. (Unit: kBq m^{-2})

Month	Precipitation (m)	10 m^2 rain collector
July	0.011	0.043
August	0.018	0.040
September	0.048	< 0.120
October	0.081	< 0.203
November	0.031	< 0.078
December	0.055	< 0.138
Sum	0.244	< 0.622

Table 3.1. Radionuclides in sediment samples collected at Bolund in Roskilde Fjord. (cf. Fig. 3.1) July - December 2013. (Unit: Bq kg^{-1} dry)

Date	^{137}Cs	K*
27 July	1.0	18.5
*Unit: g kg^{-1} dry		

Table 4.1. Radionuclides in seawater collected in Roskilde Fjord (cf. Fig. 4.1) July - December 2013. (Unit: Bq m^{-3})

Date	^{137}Cs
27 July	11.7

Table 4.2. Tritium in seawater collected in Roskilde Fjord (Risø pier) (cf. Fig. 4.2) July - December 2013.

Month	kBq m^{-3}
September	< 2.5 *
December	< 2.5 *
* Double determinations	

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Table 5.1. Radionuclides in grass (snow) collected at Risø (near the Waste Treatment Station (cf. Fig. 1)), July - December 2013. (**Measured on bulked ash samples)*

Week no. or month	Date	K (g kg^{-1} fresh)	^{137}Cs (Bq kg^{-1} fresh)	^{137}Cs (Bq m^{-2})
27	1 July	5.7	< 0.5	
29	15 July	7.2	< 0.7	
31	29 July	10.6	< 1.0	
33	12 August	8.6	< 0.9	
35	26 August	8.5	< 0.7	
37	09 September	5.5	< 0.4	
39	23 September	4.1	< 0.9	
41	7 October	4.6	< 1.0	
43	21 October	3.6	< 0.6	
45	4 November	2.8	< 0.5	
47	18 November	2.8	< 0.5	
49	2 December	3.5	< 0.8	
51	16 December	1.5	< 0.7	
53	30 December	3.3	< 0.8	
**July		6.6	0.102	0.034
**August		8.9	0.486	0.088
**September		5.8	0.280	0.092
**October		4.1	0.080	0.014
**November		2.9	0.049	0.019
**December		2.7	0.286	0.053

Table 5.2. Radionuclides in Fucus vesiculosus collected at Bolund in Roskilde Fjord. July - December 2013. (Unit: Bq kg^{-1} dry)

Date	^{137}Cs	K*	% dry matter
24 July	2.5	25	21

*Unit: g kg^{-1} dry

Table 7.1. Waste water collected at Risø (cf. Fig. 1), July - December 2013.

Week number	eqv. mg KCl l^{-1}	^{137}Cs (Bq m^{-3})	^{131}I (Bq m^{-3})	^{226}Ra (Bq m^{-3})
27	140	< 106	< 110	< 206
28	141	< 108	< 116	< 207
29	146	< 99	< 105	< 200
30	140	< 97	< 108	< 204
31	138	< 109	< 114	< 206
32	145	< 112	< 114	< 234
33	182	< 66	< 68	< 142
34	156	< 106	< 120	< 207
35	174	< 111	< 117	< 222
36	167	< 110	< 113	< 210
37	124	< 137	< 145	< 297
38	136	< 67	< 66	< 155
39	130	< 103	< 112	< 200
40	134	< 99	< 107	< 203
41	146	< 105	< 112	< 221
42	151	< 101	< 130	< 204
43	162	< 113	< 123	< 219
44	172	< 63	< 73	< 124
45	165	< 107	< 114	< 214
46	107	< 106	< 111	< 205
47	121	< 111	< 119	< 223
48	102	< 101	< 103	< 204
49	114	< 104	< 108	< 206
50	109	< 114	< 120	< 221
51	85	< 91	< 49	< 134
52	89	< 128	< 316	< 272
53	77	< 108	< 201	< 218
Mean	135.3			
SD	27.9			

Table 8.1. Background dose rates around the border of Risø (cf. Fig. 8.1) measured with thermoluminescence dosimeters (TLD) in the period May - October 2013. (Results are normalized to nSv h^{-1})

Location	nSv h^{-1}
1	40
2	39
3	32
4	44
5	40
6	44
Mean	40

Table 8.2. Background dose rates around Risø (cf. Fig. 8.2 and Fig. 1) measured with thermoluminescence dosimeters (TLD) in the period May – October 2013. (Results are normalized to nSv h^{-1})

Risø zone	Location	nSv h^{-1}
I	1	30
I	2	41
I	3	64
I	4	29
I	5	56
Mean		44
II	P1	34
II	P2	54
II	P3	47
II	P4	48
Mean		46
III	P1	42
III	P2	44
III	P3	44
Mean		43
IV	P1	29
IV	P2	27
IV	P3	36
IV	P4	34
IV	P5	29
IV	P6	33
IV	P7	-
Mean		31
V	P1	38
V	P2	44
V	P3	139*
V	P4	28
V	P5	52
V	P6	47
V	P7	47
V	P8	45
V	P9	39
V	P10	43
Mean		52

Note to Table 8.2. The standard deviation for the 4 pills in the dosimeter that measured 139 nSv/h at Ledhøje is ca. 10 %. It must therefore be concluded that the measurement is correct, but it is unknown what caused this deviating measurement result.

Table 8.3. Terrestrial dose rates at the Risø zones (cf. Fig. 8.2 and Fig. 1) July - December 2013. Measured with a NaI(Tl) detector. (Unit: nSv h^{-1})

Risø zone	Location	October
I	P1	41
I	P2	55
I	P3	328
I	P4	50
I	P5	83
Mean		112
II	P1	47
II	P2	49
II	P3	44
II	P4	46
Mean		46
III	P1	50
III	P2	53
III	P3	49
Mean		51
IV	P1	47
IV	P2	52
IV	P3	48
IV	P4	48
IV	P5	36
IV	P6	47
IV	P7	47
Mean		46
V	P1	43
V	P2	55
V	P3	56
V	P4	49
V	P5	53
V	P6	56
V	P7	50
V	P7a	47
V	P8	52
V	P9	54
V	P10	42
Mean		51

Fig. 1. Locations for measurements of gamma-background radiation Zone I and II (cf. Tables 8.2 and 8.3)

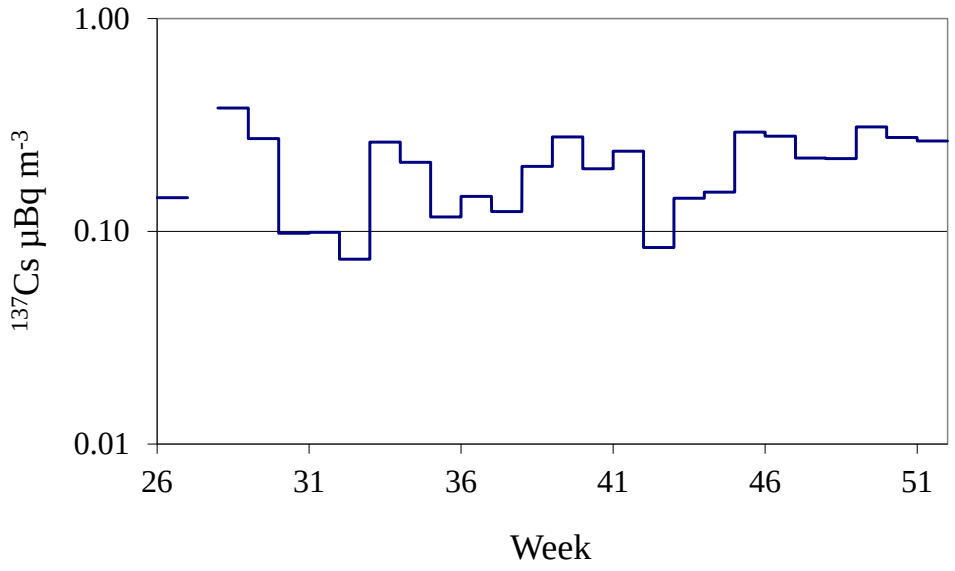

Fig. 1.1. Caesium-137 in ground level air collected at Risø in July-December 2013. (Unit: µBq m^{-3})

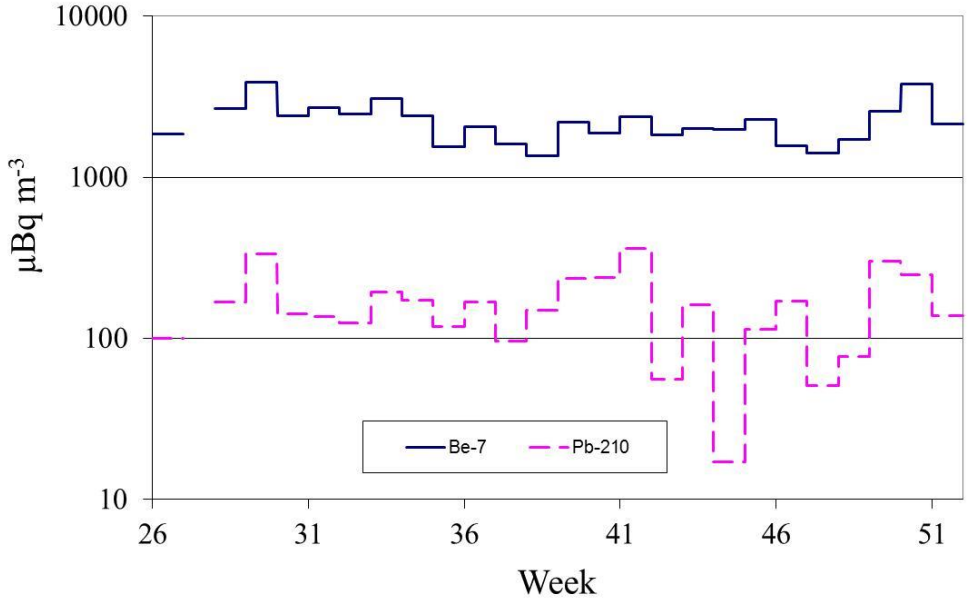

Fig. 1.2. Beryllium-7 and lead-210 in ground level air collected at Risø in July-December 2013. (Unit: µBq m^{-3})

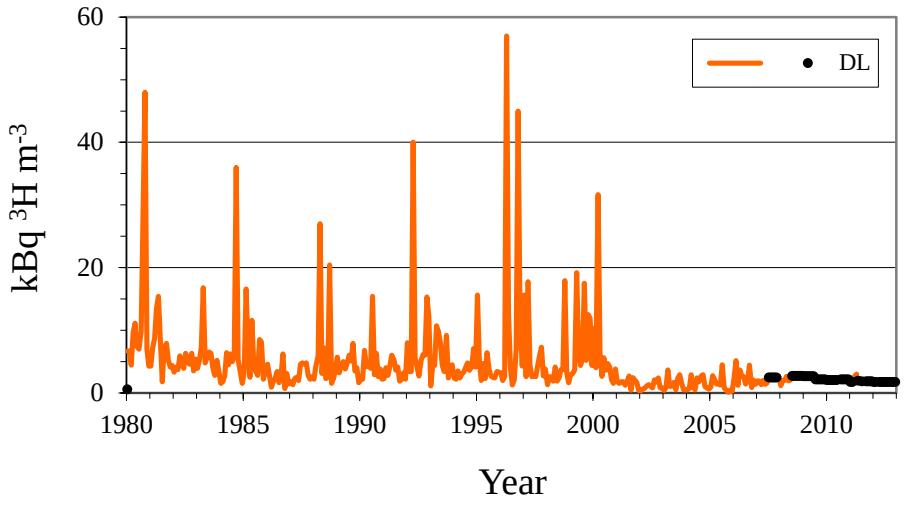

Fig. 2.3.1. Tritium in precipitation collected at Risø (1 m^2 rain collector) 1980 - 2012. (Unit: kBq m^{-3}; DL = detection limit). This rain collector was taken out of operation in 2013.

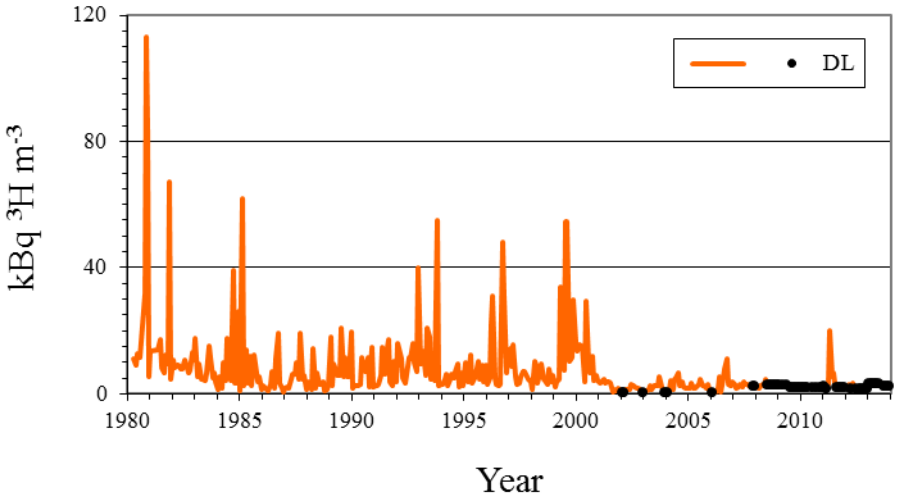

Fig. 2.3.2. Tritium in precipitation collected at Risø (10 m^2 rain collector) 1980 - 2013. (Unit: kBq m^{-3}; DL = detection limit)

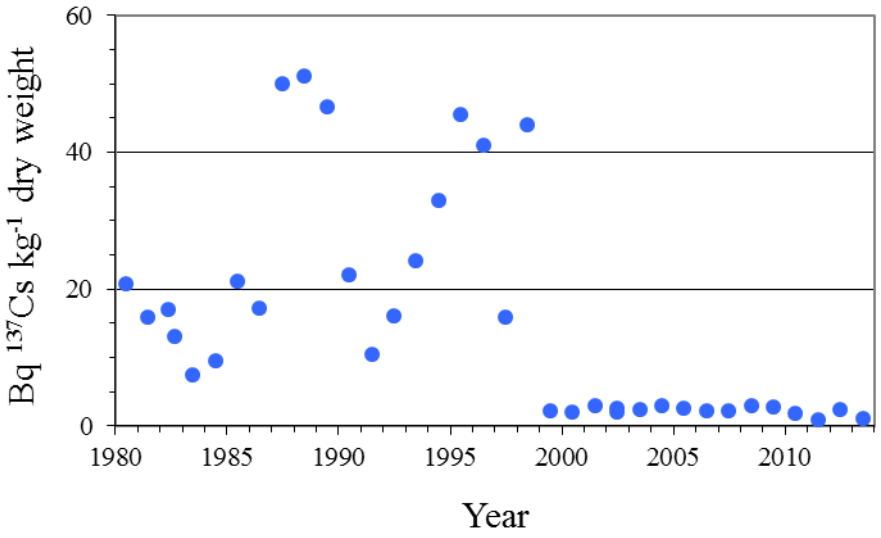

Fig. 3.1. Caesium–137 in sediment samples collected at Bolund in Roskilde Fjord. 1980 – 2013. (Unit: Bq kg^{-1} dry matter)

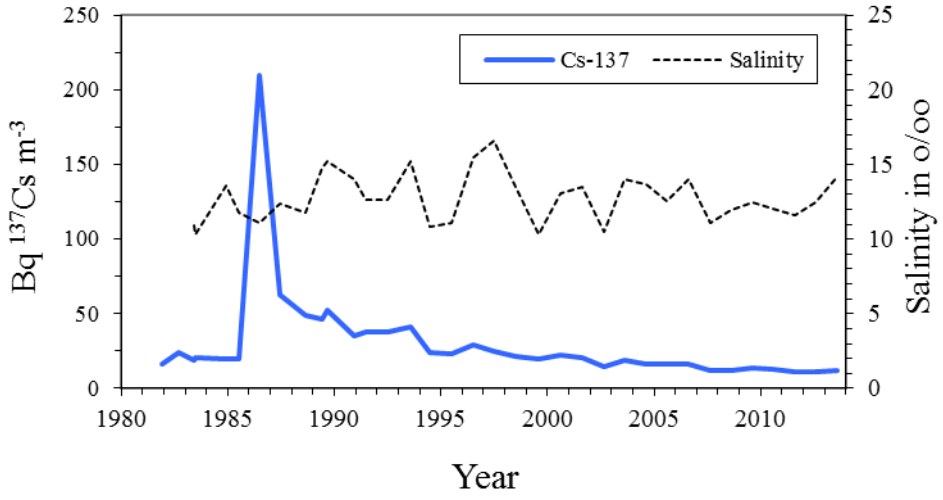

Fig. 4.1. Caesium–137 in seawater collected in Roskilde Fjord 1980 - 2013. (Unit: Bq m^{-3})

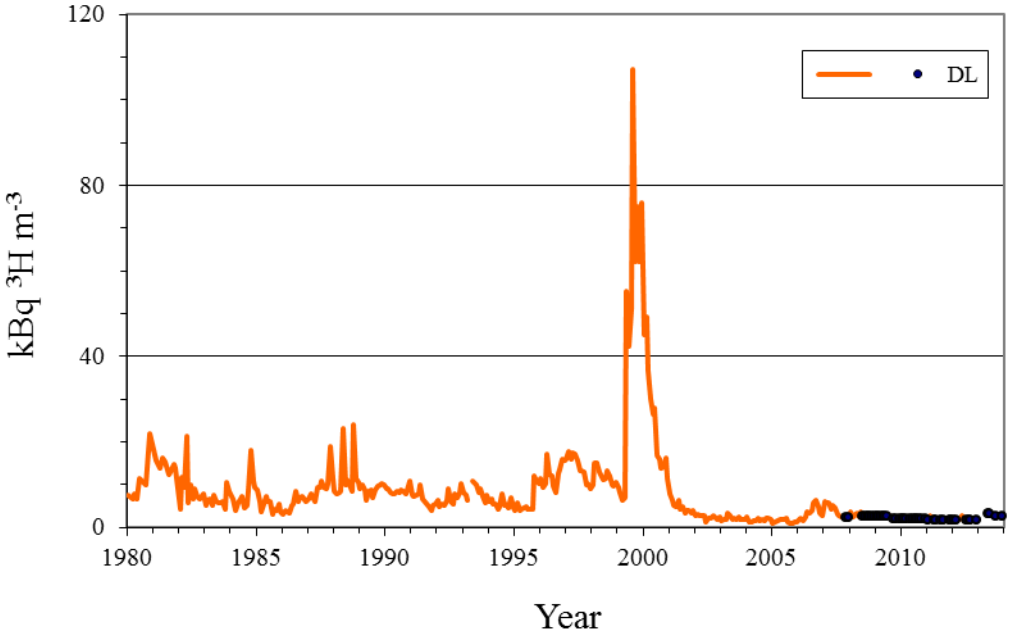

Fig. 4.2. Tritium in seawater collected in Roskilde Fjord 1980 - 2013. (Unit: kBq m^{-3}; DL = detection limit)

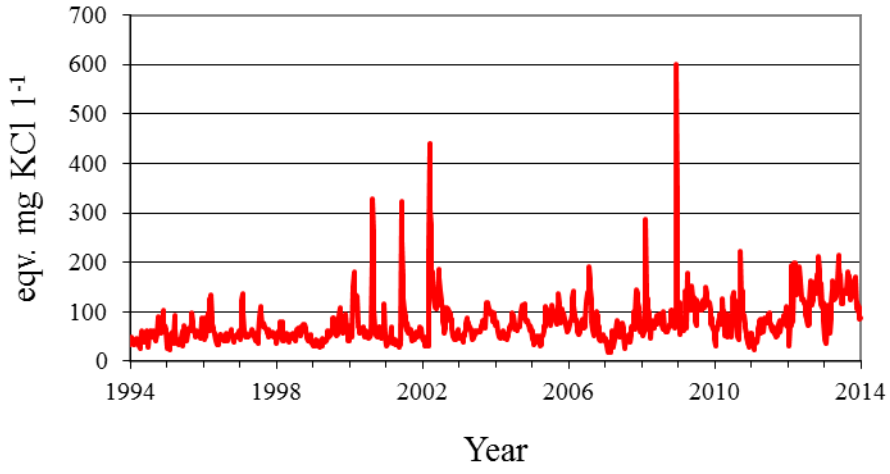

Fig. 7.1. Total-beta radioactivity in waste water collected at Risø 1994 - 2013. (Unit: eqv. mg KCl l^{-1})

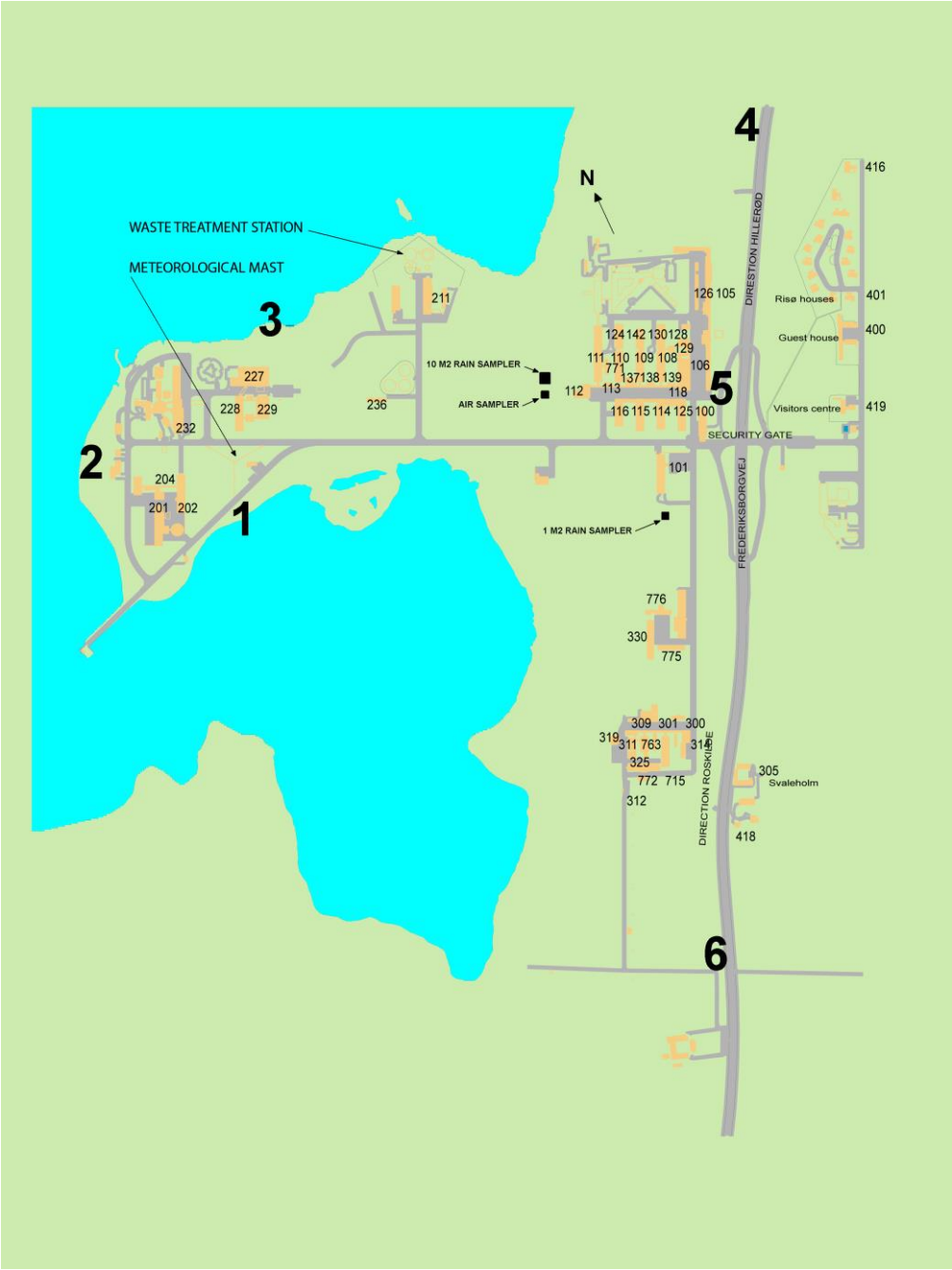

Fig. 8.1. Locations (1-6) for TLD measurements around the border of Risø (cf. Table 8.1).

Fig. 8.2. Locations for measurements of background radiation around Risø in Zones III, IV and V.

Center for Nuclear Technologies is Denmark's national competency center for nuclear technology. With roots in research in the peaceful use of nuclear power, DTU Nutech works with the applications of ionizing radiation and radioactive substances for the benefit of society.

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